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ANALYSIS OF PREDATOR-PREY BALANCE IN BANDIPUR TIGER RESERVE WITH REFERENCE TO CENSUS REPORTS[1]

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The deciduous forest habitats of the 690 km² Bandipur tiger reserve in Karnataka State harbour major mammalian predators such as tiger, leopard and dhole supported by a large and diverse assemblage of prey species. It is reported that populations of these animals have increased dramatically in recent years, in response to improved management practices. These conclusions are drawn on the basis of population estimates of different species obtained using several census techniques currently in practice. In this paper I have examined the broad predator-prey balance among larger mammals of the reserve using the 1982 census figures, integrating ecological data on these species from several recent studies into the analysis.

This analysis suggests that the predator and prey population estimates are not meaningful. Comparisons of distributional density and biomass of different species and the total prey biomass calculated here with those obtained from other important studies in the Indian sub-continent reinforce these conclusions. Therefore, a radical revision of all the present census techniques and introduction of appropriate modern census methods are recommended.

Introduction

The deciduous forests of the 690 km² Bandipur tiger reserve described by Neginhal (1974) harbour a diverse assemblage of large mammals (Table 1). Due to strict control over biotic interferences and systematic management under 'Project Tiger' since 1973, it is reported that populations of large mammals have increased substantially. This claim is supported by the annual census reports. Particularly notable is the reported increase of tiger population from 11 in 1973 to 54 in 1984 (Basappanavar 1985).

The census of tigers/leopards is made from pugmarks; elephant and gaur from 'visual counts' and other animals from 'sample counts'

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(Basappanavar 1985). During the October 1982 census, which I observed, the entire reserve was divided into 103 compartments (average 6.9 km²) and between 0600-1600 hrs three member teams perambulated each compartment thoroughly, following no predetermined path. They collected 'plaster casts' of pugmarks and recorded animal sightings on a printed form. This field data was later consolidated to arrive at the census estimates (Table 2).

In this paper I have tried to analyse the predator-prey balance for the reserve based on these estimates. I have focussed my analysis on the larger carnivores, as they are sensitive indicators of habitat quality and may be studied at greater profit to gauge the health and extent of an environment to be preserved (Eisenberg 1980).

To simplify the analysis I have made the following assumptions:

(i) The large predators are cropping only the incremental prey biomass annually, without depleting the prey base.

(ii) Chital, sambar, muntjac, wild pig, gray langur and livestock form the major prey and accounted for 75% of the intake of tiger, leopard and dhole.

Relative numbers of predators and prey

Prey requirements of predators

Studies by Schaller (1967), Sunquist (1981) and Tamang (1982) indicate that tigers on an average need about 3000 kg of prey every year. On this basis the 49 tigers estimated in the 1982-83 census have an annual prey requirement of 1,47,000 kg. Similarly, the annual prey requirement of the leopard appears to be about 1,000 kg (Schaller 1967, Muckenhirn and Eisenberg 1973). The requirement of 50 leopards reported would be 50,000 kg per year. Johnsingh (1983) estimated the annual prey requirement of an adult dhole at 680 kg. Being coursing predators, presumably they have a higher energy expenditure per unit body weight in comparison to the two felines which are stalking predators. Considering subadults and pups in the population which have lower requirements, it is reasonable to presume an average annual requirement of 340 kg of prey per dhole. On this basis, the estimated population of 152 dhole needs 51,680 kg of prey per year. Therefore the total annual prey intake of all the tigers, leopards and dholes estimated to exist in Bandipur reserve during 1982-83 works out to 2,48,680 kg.

During 1982-83, 131 cattle were reported to be killed by large predators in and around the reserve (Basappanavar 1985). Including unreported cases the maximum number of cattle killed can be assumed to be 200, since the villagers usually report any kill to claim compensation. At an average unit weight of 150 kg, these cattle met the prey requirement to the extent of 30,000 kg. Other minor wild prey species (Gaur, four-horned antelope, black-naped hare, bonnet monkey, peafowl etc.) consist of 25% of the total prey intake (as per assumption No. ii) and account for an additional 62,170 kg.

Therefore, the total weight of major wild prey species (chital, sambar, muntjac, wild pig and gray langur) consumed by large predators during the year was 1,56,510 kg (say 1,56,000 kg) based on census estimates of predators.

Availability of major wild prey species

In table 2, I have worked out the crude density and crude biomass of the major wild prey species using census data. From this it is seen that during 1982-83 Bandipur reserve had a standing biomass of 1,29,770 kg (say 1,30,000 kg) of major wild prey. What proportion of this biomass was cropped by predators?

TABLE 1

LARGE MAMMALS RECORDED IN BANDIPUR TIGER RESERVE*

Scientific Name	Common Name
PRIMATA	
Macaca radiata	Bonnet macaque
Presbytis entellus	Gray langur
Loris tardigradus	Slender loris
LAGOMORPHA	
Lepus nigricollis	Blacknaped hare
RODENTIA	
Hystrix indica	Indian porcupine
Ratufa indica	Indian giant squirrel
Petaurista petaurista	Large brown flying squirrel
CARNIVORA	
Panthera tigris	Tiger
Panthera pardus	Leopard
Felis chaus	Jungle cat
Felis bengalensis	Leopard cat
Viverricula indica	Small Indian civet
Paradoxurus hermaphroditus	Common palm civet
Lutra lutra	Common otter
Melursus ursinus	Sloth bear
Herpestes edwardsi	Common mongoose
Herpestes smithi	Ruddy mongoose
Herpestes vitticollis	Stripenecked mongoose
Canis aureus	Jackal
Cuon alpinus	Dhole
Hyaena hyaena	Striped hyena
PROBOSCIDEA	
Elephas maximus	Indian elephant
ARTIODCTYLA	
Bos gaurus	Gaur
Tetracerus quadricornis	Four horned antelope
Sus scrofa	Wild pig
Muntiacus muntjak	Muntjac
Cervus axis	Chital
Cervus unicolor	Sambar
Tragulus meminna	Chevrotain
PHOLIDOTA	
Manis crassicaudata	Indian pangolin

* From Neginhal (1974) and personal observations.

Table 2

Densities and biomass of selected large mammals in Bandipur tiger reserve derived from the 1982-83 census estimates

Species	Census Estimates	Density Nos./km²	Unit wt.* kg	Average Biomass Kg/km²	Total Standing Biomass Kg
Wild Prey					
Gaur	551	0.79	545.0	435.21	300 295
Sambar	342	0.50	113.6	56.30	38 851
Chital	1333	1.93	45.0	86.93	59.985
Muntjac	92	0.13	13.4	1.78	1 233
Wild pig	772	1.12	25.8	28.86	19 917
Gray langur	1223	1.77	8.0	14.18	9 784
			Total:	623.26	430 065
Predators					
Tiger	49	0.0710	150.0	10.65	7 350
Leopard	50	0.0725	45.0	3.26	2 250
Dhole	152	0.2203	18.0	3.97	2 736
			Total:	17.88	12 336

* The average unit weight for the species is selected from: Schaller (1967) for Gaur, chital and wild pig; Seidensticker (1976) for sambar; Eisenberg & Lockhart (1972) for muntjac; Johnsingh (1983) for gray langur and dhole; and Eisenberg (1980) for tiger and leopard.

Schaller (1972) and Sunquist (1981) estimated that annually predators remove about 10% of the standing biomass. Johnsingh (1983) estimated it at 20% in his study area of 20 km² around Bandipur campus. However, he attributed this higher rate of removal to the additional predation caused by the sudden withdrawal of livestock from the area just prior to his study.

Thus a maximum annual cropping by predators of the order of 15% seems reasonable for this analysis. Therefore, the possible annual removal of biomass of major wild prey species by the large predators works out to 19,500 kg. However as seen earlier annual consumption of such prey amounts to 1,56,000 kg, based on census estimates of predators. The annual cropping by predators seems to exceed the standing biomass of major prey species!

These calculations indicate that the official census estimates of large predators are significant overestimates and those of major prey species are possibly underestimates.

Biomass of prey

Eisenberg and Seidensticker (1976) have synthesized the information on ungulate biomass and densities from several studies in South Asia. Johnsingh (1983) has assessed these for his 20 km² study area in Bandipur reserve, which is the best wildlife area in the entire reserve. Based on published data and census estimates I have presented the densities and biomass for the major prey species (Table 2).

The biomass figures calculated above can be compared to those from other studies cited above. Biomass figures of 383 kg/km² for Gir forest, 1708 kg/km² for Kanha reserve and 3,382 kg/km² for Johnsingh's 20 km² study area in Bandipur are available. In spite of lower incidence of livestock grazing pressure the calculated biomass of major prey species works out to only 623 kg/km² in comparison. From the above comparison, the estimated prey biomass and hence the census estimates on which they are based appear to be too low for Bandipur tiger reserve.

Densities and Biomass of Predators

Johnsingh (1983) who pioneered the study of dhole in Bandipur estimated that the mean number of dhole varied between 7-18 in his study area. This yields a density of 35 to 90 dhole/100 km². However, it must be noted that his study area had a high density of prey and ecologically almost ideal habitat conditions for dholes. The reserve as a whole is more densely forested and has a lower prey density. Therefore, the density of 22 dhole/100 km² obtained from census estimate appears rather high.

While high densities of 17-20 leopards/100 km² are reported from habitats in Sri Lanka (Eisenberg 1980, Santiapillai *et al.* 1982) where competing predators like tiger and dhole are entirely absent, the reported density of 7.25 leopards/100 km² in Bandipur needs to be cautiously viewed, in the absence of any corroborative evidence.

Studies of the tiger in Kanha by Schaller (1967), Panwar (1979a) show densities 3.1-4.7 animals/100 km². Intensive radio-tracking studies (Sunquist 1981, Tamang 1982, Sunquist and Mishra, *in press*) in Chitwan have yielded density estimates of 2.3-3.7 tigers/100 km². These study sites were notable for the virtual absence of dholes and carried substantially higher prey biomass in comparison with the post-1973 Bandipur reserve. Inspite of this, the census estimates yield an extraordinarily high density of 7.10 tigers/100 km² indicating a significant overestimate for this species.

The predator to prey biomass ratios calculated using census estimates works out to 1:35 for Bandipur reserve as against 1:250 for Serengeti, 1:100 for Ngorongoro, 1:123 for Chitwan, 1:75 for Wilpattu and 1:124 for Johnsingh's study area (Ratios calculated from Schaller 1972, Eisenberg 1980, Eisenberg and Seidensticker 1976 and Johnsingh 1983).

On the basis of the above analysis it can be concluded that:

(i) The census estimates for large predators in general and tigers in particular are significant overestimates.

(ii) The census estimates of prey species are not meaningful and might be underestimates.

(iii) Therefore, the census techniques currently used in Bandipur tiger reserve are basically wrong and need to be modified keeping in view recent trends and developments in wildlife management.

Census Methods

A Review of present Census Techniques

The census estimates of tigers/leopards are now obtained at Bandipur using the pugmark tracing technique developed by Choudhury and described by Panwar (1979b). Apart from not having been validated on a known population anywhere, the technique demands a great deal of personal skill on the part of the practitioner. In addition to this subjective bias the following errors might have led to the overestimates in Bandipur:

(i) Absence of continuous year-round recording of pugmarks and assigning home-ranges to individual resident animals as done by Panwar (1979a) and McDougal (1977). The once a year census of Bandipur does not enable identification of individual animals with their home ranges.

(ii) Classification of the pugmarks of a single animal as those of several animals due to the differences caused by substrate conditions.

(iii) Collection of pugmarks of different limbs and collection of pugmarks from distant localities made over a 2-3 day period.

The estimates for elephant and gaur are reported to be from 'visual counts' and of other species from 'Sample counts' (Basappanavar 1985). Both these estimates are likely to be wrong due to the following reasons:

(i) Due to the limited visibility the census teams fail to actually obtain a total count of gaur and elephants. However, since these animals range over considerable distances, often in response to the census activity itself, some of them are likely to be counted by two or more adjoining census parties. Therefore, these cannot be considered total counts.

(ii) Since the census teams do not follow a repeatable pre-determined transect and do not also maintain any record of the width/length of the forest strip being sampled, the counts of other species also cannot be accepted as sample counts.

In practice, however, the reserve managers seem to treat these arbitrary counts of all species as total counts (Basappanavar 1979, Wesley 1977) leading to estimates which are not meaningful.

Alternative Methods and Techniques

Before suggesting alternatives, the following points summarised from Caughley (1977) need consideration. The abundance of an animal species can be measured in three ways:

(i) Number of animals in a population (*census* or *total count*).

(ii) Number of animals per unit area (*absolute density*).

(iii) Density of one population relative to another — e.g., between different years or different locations (*relative density*).

Most ecological and management problems can be tackled with the help of suitable *indices of relative density* and many others with the help of *absolute density estimates. Total counts* have very few practical uses. I have outlined here, briefly, some alternate methods for estimating abundance of mammalian species at Bandipur keeping these points in view. Wherever possible, I have referred to some sources on the theory and practice of these alternate techniques:

(i) Relative density of tigers/leopards between localities or years can be estimated using suitably designed indices like number of tracks/scats/sightings per km of roads traversed (Joslin 1973).

(ii) Absolute density of tigers/leopards can be estimated using home-ranges determined through systematic, year-round pugmark collections (McDougal 1977, Panwar 1979b). Identification of specific individuals from facial markings/coat patterns from photos obtained with camera trap devices can *validate* these estimates (McDougal 1977).

(iii) For all the reasonably abundant large mammalian species good indices of relative density in stratified habitats can be derived from roadside counts from vehicles, counts at water holes/feeding spots (Caughley 1977, Overton 1971, Berwick 1974, Dinerstein 1980).

(iv) For smaller, shy or nocturnal species e.g., rodents, mongooses, civets, smaller felids indices of relative densities can be obtained using capture-mark-recapture techniques (Overton 1971, Begon 1979 and Anon. 1981).

(v) Indices of relative densities for a wide range of species, particularly ungulates, can be obtained from pellet group/scat counts from linear strips or quadrats (Overton 1971, Mishra 1982).

(vi) For a large number of reasonably abundant diurnal mammals absolute densities can be estimated in stratified habitats using line transect censuses, particularly from elephant back. It has been successfully used in Nepal and has developed rapidly in recent years incorporating computer analysis of the field data (Caughley 1977, Burnham *et al.* 1980, Anon. 1981, Seidensticker 1976, Mishra 1982 and Tamang 1982).

(vii) Absolute densities for many diurnal species can also be estimated from sweep/drive censuses of smaller patches of forests (Overton 1971) since manpower is not a constraint at Bandipur.

(viii) For thinly distributed diurnal species e.g., dhole, bonnet macaque, four-horned antelope, systematic observations of previously marked animals may yield home-range size and hence absolute density estimates. For nocturnal, thinly distributed, or hard to observe species e.g., civets and lesser felids home-ranges and absolute density estimates can be obtained by repeated recapture of marked individuals in a series of traps (Overton 1971, Begon 1979 and Anon. 1981).

In conclusion, I must stress here that my analysis does not deny the spectacular success of 'Project Tiger' in Bandipur. It has the limited aim of evaluating the present census techniques so that more scientifically valid methods are evolved. Such methods will be more appropriate for quantifying the undisputed success achieved by wildlife managers during the last decade in Bandipur and elsewhere in the country.

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